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Collaborative mapping of emerging cities in developing countries: the *León Emergente* project

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ABSTRACT

In the expanding constellation of collaborative map-making initiatives, a growing number of small local projects coexist along with more ambitious and global ones. In developing countries, their existence is not only compatible and complementary, but also necessary, since they meet different needs and pursue diverse and essential objectives, in addition to collecting and sharing geo-located data. In this context, this paper describes the *León Emergente* initiative, a collaborative living atlas for the city of León in Nicaragua. The results are presented through two main maps that illustrate, for the first time, the formal and informal economic activity of the city as well as the health facilities in relation to the distribution of population across the city. The paper also describes the *Leon Emergente* online platform and presents a number of online maps that not only represent, but also collect data on different urban aspects and dynamics.

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1. Introduction

New forms of collaborative productions and processes have recently emerged in a wide range of disciplines. The field of map-making has been particularly fertile for these emerging practices, with the rise of the so-called collaborative, participatory or community-based mapping. However, the more general terms 'Volunteered Geographical Information' (VGI) (Goodchild, 2007a) or 'Participatory Spatial Information Systems' (PGIS) (Rambaldi, Kyem, McCall, & Weiner, 2006) probably better communicate the wider scope of some initiatives that are not actually focused on mapping, but rather on providing geo-located information that is either automatically mapped or charted by others.

Map-making collaborations are probably as old as maps themselves, but current practices are the result of a technological revolution that started more than 25 years ago. While in the 1980s Participatory Rural Appraisal (PRA) methods were still based on sketch mapping (Rambaldi et al., 2006), in the 1990s map-making began undergoing a huge change, becoming a more accessible practice due to the dissemination of Geographic Information Systems (GIS), remote sensing imagery and Global Positioning Systems (GPS) (Chambers, 2006). Finally, in the 2000s, the internet and especially the birth of the so-called Web 2.0 (Goodchild, 2007b) allowed for the online participation that led to the term 'crowdsourcing' (Jankowski, 2009) and to the current new methods of map-making. The launch of the Open Street Map (OSM) project in 2004 represents a key milestone in the recent history of collaborative map-making. Born at the University College of London, OSM quickly spread worldwide. Currently, it is the most extensive and ambitious initiative (Haklay & Weber, 2008), with an exponentially growing number of registered users. Its massive community recently reached 2.2 million users (OpenStreetMap Wiki, 2015), but it is important to highlight that their contributors include not only individuals, but also entire institutions or companies that donate huge databases. For instance, in 2007 the Automotive Navigation Data (AND) donated the street network of the entire Netherlands (OpenStreetMap, 2007).

OSM and other global initiatives, such as Wikimapia (www.wikimapia.org) are good representatives of the new collaborative map-making revolution. Nevertheless, many other smaller collaborative initiatives are playing an important role along with them. A large constellation of local map-making projects are being launched worldwide, usually more focused on specific sites or precise objectives, ranging from increasing participation in planning processes (Badenhope & Seeger, 2014) to creating a tool for decision support (Balram, Dragicevic, & Feick, 2009), social empowerment (Di Gessa, Poole, & Bending, 2008) or to visualize and understand underexplored urban dynamics (Romanillos & Zaltz Austwick, 2015).

Some of these local collaborative mapping initiatives are taking place in developing countries. Although they pursue a wide range of goals, most of them are mainly

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focused on mapping territories and emergent cities that are lacking the required information or necessary data accuracy to support planning (Atzmanstorfer, Resl, Eitzinger, & Izurieta, 2014) or certain basic services, such as transport (Klopp, Williams, Waiganjo, Orwa, & White, 2015). Collaborative map-making in these countries are having a positive impact, although a caveat must be considered: there may be potential negative effects when participatory mapping becomes an elitist technology (Reyes-García et al., 2012). Local initiatives may be aware of this risk and promote the participation of diverse local groups, avoiding or reducing possible biases or conflicts of interest.

The goal of this paper is to describe the objectives, the methodology and the outputs – especially the resulting maps – of the *León Emergente* project, an initiative that aims at creating an online collaborative atlas for the city of León in Nicaragua.

2. The *León Emergente* project

2.1. Background and main objectives

León Emergente is a research and cooperation project developed in the city of León (Nicaragua). It is set within the framework of a broader project, which is aimed at fostering innovative *Local Development* strategies, with a special focus on the application of GIS tools.

The city of León is the second-largest city in Nicaragua, with over 200,000 inhabitants (Instituto Nacional de Información de Desarrollo, 2012) and is the most important city in the Department of León (populated by around 400,000 people), centralizing most of its main facilities and services. León is also one of the most developed cities in Nicaragua, hosting the oldest university in the country, which is still among the most important. Despite all this, local policy-makers, urban planners and other actors involved in territorial planning have serious difficulties when working on new plans and policies aimed at promoting sustainable social and economic development. The main problems are the lack of basic information and the absence of certain technical education and tools. For instance, when this project began, the municipality did not have a geo-located dataset regarding retail activity, technicians did not have an accurate land-use plan and there was no public transport map available to anyone (especially necessary for tourists or foreigners).

2.2. The León Emergente online platform and the participation process

The *León Emergente* project was developed over the course of different steps, involving three different groups of participants. The first step was to contact the local actors involved in local development and planning, hailing from the municipality, the university and other institutions, such as Medina, a Non-Governmental Organization (NGO) focused on urban planning in developing countries. The project was developed along with them, according to their needs, identifying the main issues to tackle. They can be considered the first group of contributors. During the second step, after promoting the initiative in the different aforementioned organizations, a group of technicians and students were engaged as volunteers and then introduced to GIS applications on local development and planning, and to the basics of online map-making through a specific course, so that they could become autonomous once the project was finished. They are the second group of participants, and they also contributed to the definition of the *León Emergente* online platform, which was finally developed by the research team in a third step. Finally, the fourth step was to promote the initiative and start data collection, which is still underway. In this step, the participatory process was open to the public – the third group of contributors –, so that everyone can now contribute to the maps through the online platform. The initiative was promoted mainly through local social networks and also with some advertisement posters in different public locations.

The *León Emergente* online platform (www.emergenteleon.org) is the core of the project, an initiative launched in April 2015 that is still running. The platform pursues different objectives. The first one is to support the digital atlas; in other words, a number of online maps that illustrate different aspects of the city of León. However, these maps do not only represent existing information, mainly provided by the municipality. Most of them are collaborative online maps that are oriented toward collecting data. Therefore, the second goal is to turn the platform into a living atlas, a dynamic tool that captures and represents new data gathered from volunteers.

The third objective is to make all the collected data and maps public and available to the community. Technicians or policy-makers can now download the data for planning purposes, researchers and students to perform different analyses and the private sector can benefit from the information, as well. For instance, different travel agencies or tourist services may embed online maps on their own websites, providing information about public transport or about the main tourist destinations and activities.

Collaborative initiatives rely on the participation of people, so in order to achieve these objectives, it was important to attain the greatest possible community engagement possible. For this reason, in addition to these three objectives, the platform was also aimed at creating a community of volunteers. The *León Emergente* platform was presented as an attractive website where different local traders and entrepreneurs could

find a place to let the community know about their initiatives. They can be presented on the different online maps, as well as on the *Community* webpage, where some of them were voluntarily portrayed. These measures drove the participation of volunteers and allowed them to feel like a part of a local community working on a collective project.

The participation process was explained on the website and made possible thanks to different *ArcGIS Online* applications for public edition of maps from computers (Figure 1) and different mobile devices. Volunteers could easily access the different maps on the webpage and then collaborate by simply inserting new geo-located points and associated information by filling out the form fields in the pop-up window. The maintenance process also remains quite simple. Once volunteers enter the new data, the map is updated in real time. Then, the research team and some volunteers of the 'second group of participants' regularly check the new contributions with the aim of performing a basic quality control, erasing inconsistent or outdated data. They also check the emails sent by citizens that have detected errors or outdated information, so that the maps can be corrected. According to their suggestions, at this time, volunteers can only enter new data and edit the information that they have entered. They cannot remove other people's contributions. In any case, this could easily be re-configured in order to allow volunteers to edit the entire map.

The resulting online maps making up the atlas are described as follows.

3. Results: the online urban atlas

The project was originally conceived to represent economic activity, with a special focus on the informal economy, which plays an essential role in the city. However, from the beginning, the Municipality of León and the other groups involved in the project manifested their interest in creating online maps that covered many other areas, since, as mentioned before, there were no maps for basic services such as public transport, education or health facilities. Consequently, the project shifted and was definitively conceived as a living atlas. It currently consists of 12 online maps, but this number will continue to grow, covering more and more urban aspects and dynamics. The existing online maps were created by the research team, but future maps can be – and hopefully will be – created by the aforementioned second group of participants. Current maintenance is now the responsible of certain local volunteers – those who participated in the courses given at the second stage of the project –, with the remote assistance of the visiting research team.

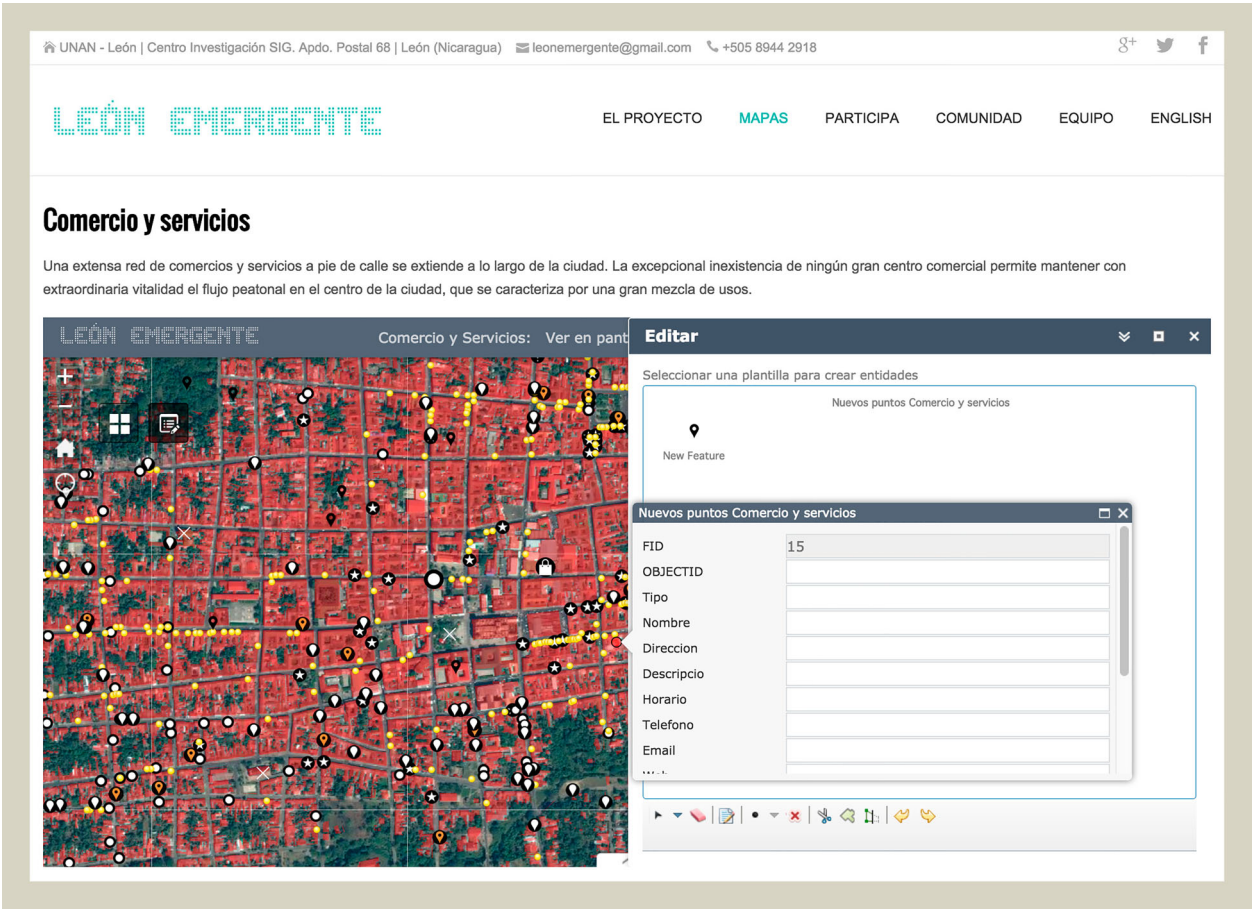

Figure 1. Screenshot of the participation process on the *Retail* online map.

Figure 2 illustrates the 12 maps currently available on the online platform, along with a brief description as follows.

(1) Informal economy. Conventional representations of cities used to ignore the ephemeral activities not sheltered by permanent structures. This map makes this wide range of informal economic activities playing a crucial role in the delivery of many services in the city of León visible. Mapping informal activities may be controversial, depending on who is behind the initiative and on the objectives that are pursued. If the goal is economic regulation of activities, mapping initiatives are not welcomed by informal traders or the majority of the society, so usually there is no room for volunteered contributions. In this case, the goal of the university and the local institutions was to spatially analyze the location of informal economy in the city and to assess its impact. Finally, informal traders were also interested and contributed, with the aim of empowering themselves by increasing their visibility as a community, since the initiative evidenced their value as a necessary infrastructure for the city. However, some of them did not trust the initiative and did not participate, afraid of possible regulation or taxation.
(2) The data are being collected mainly by volunteers from the university, although some of the records have been also entered by informal traders through the corresponding online map. Today, the map shows over 100 activities, classified as fast food services, arts and crafts, drinks and fruit corner shops and other services.
(3) Retail. Creating an exhaustive retail dataset was one of the municipality's main needs, and therefore one of the project's most important objectives. More than 850 geo-located points have been registered so far, classified into different

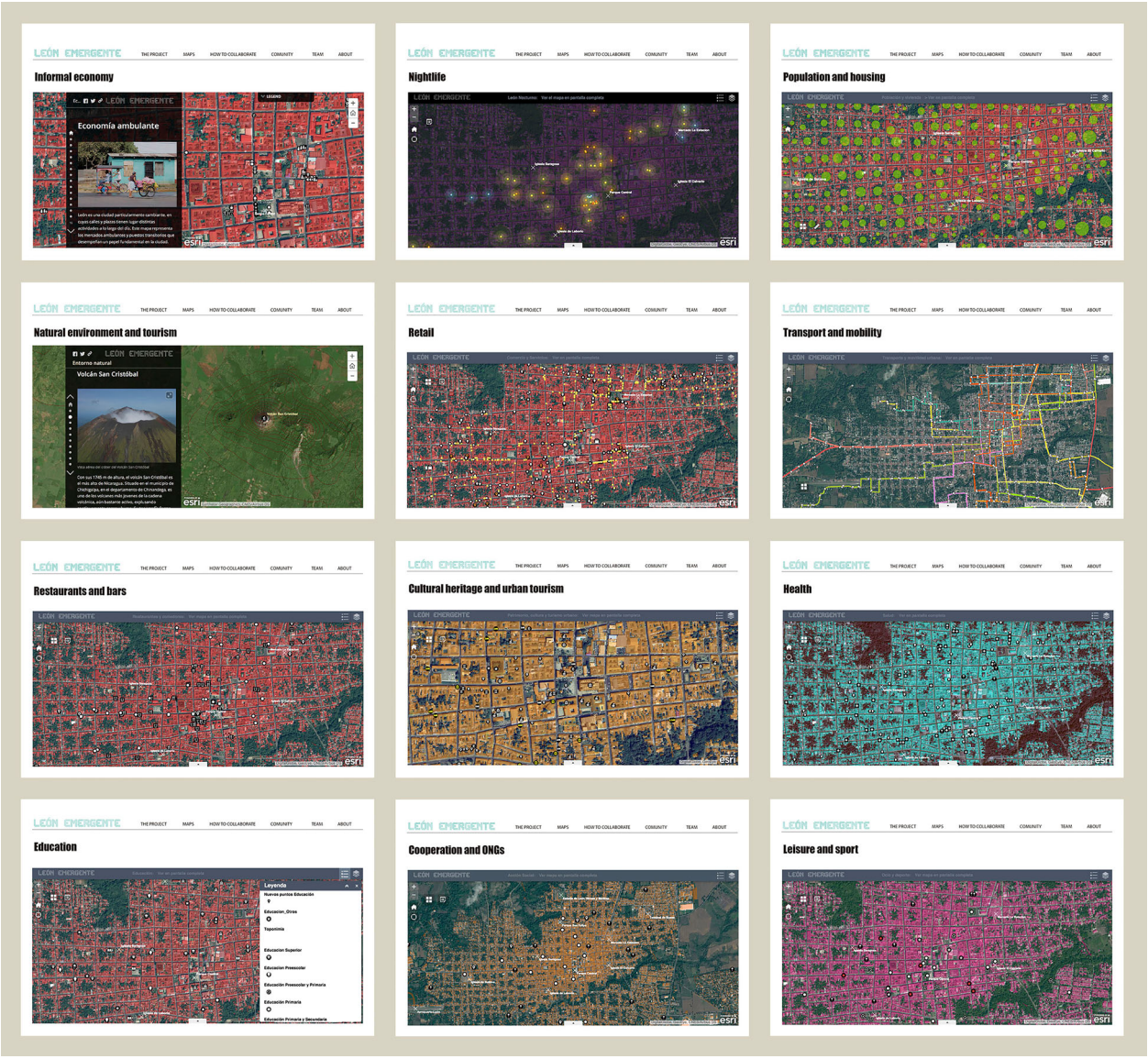

Figure 2. Different online maps available on the *León Emergente* website.

categories (corner shops, clothing stores, professional services, supermarkets, etc.). The dataset also includes basic information, such as a brief description of the retail activity, address, schedule, telephone number or website (if available). The dataset was collected in two different ways. First, the second group of participants collected information directly through street surveys, and then, once the online map was launched and made public, the map was edited and fed by many other volunteers. The dataset obtained is the most detailed one available to date.

(4) Population and housing. The map (Figure 3) illustrates population data, disaggregated by plot, as well as the constructed area. An additional map represents both datasets in an interactive fashion, showing the figures that correspond exactly to the extent of the city that the user is viewing. The map makes evident the imbalance in population distribution over the urban semi-regular grid, as well as the growing building density in central areas, which, however, does not correspond to the highest populated spaces. The datasets were provided by the Municipality of León, and correspond to 2011.

(5) Natural environment and tourism. Tourism is one of the fastest-growing economic sectors in Nicaragua in general, and in León in particular. The map represents the most important tourist points, including volcanoes and other sites of great environmental value. The map also locates the tourist agencies spread across the city, and shows their basic information. Some of these agencies are disseminating this online map by linking to the website or by embedding it on their own websites. The dataset was obtained directly from the tourism agencies.

(6) Transport and mobility. As mentioned previously, there was no public transport map available. Although not a problem for many local citizens, having one available was important for the emerging tourist industry. The map shows the different bus lines and stops that form the urban and interurban public transport system, providing their location as well as the service schedule and frequency. The data were provided by the Municipality of León.

(7) Restaurants and bars. León's inhabitants often go out for lunch or dinner. Today, the map shows around 100 points, classified as restaurants, canteens, dining halls, bars, cafes and popular ice

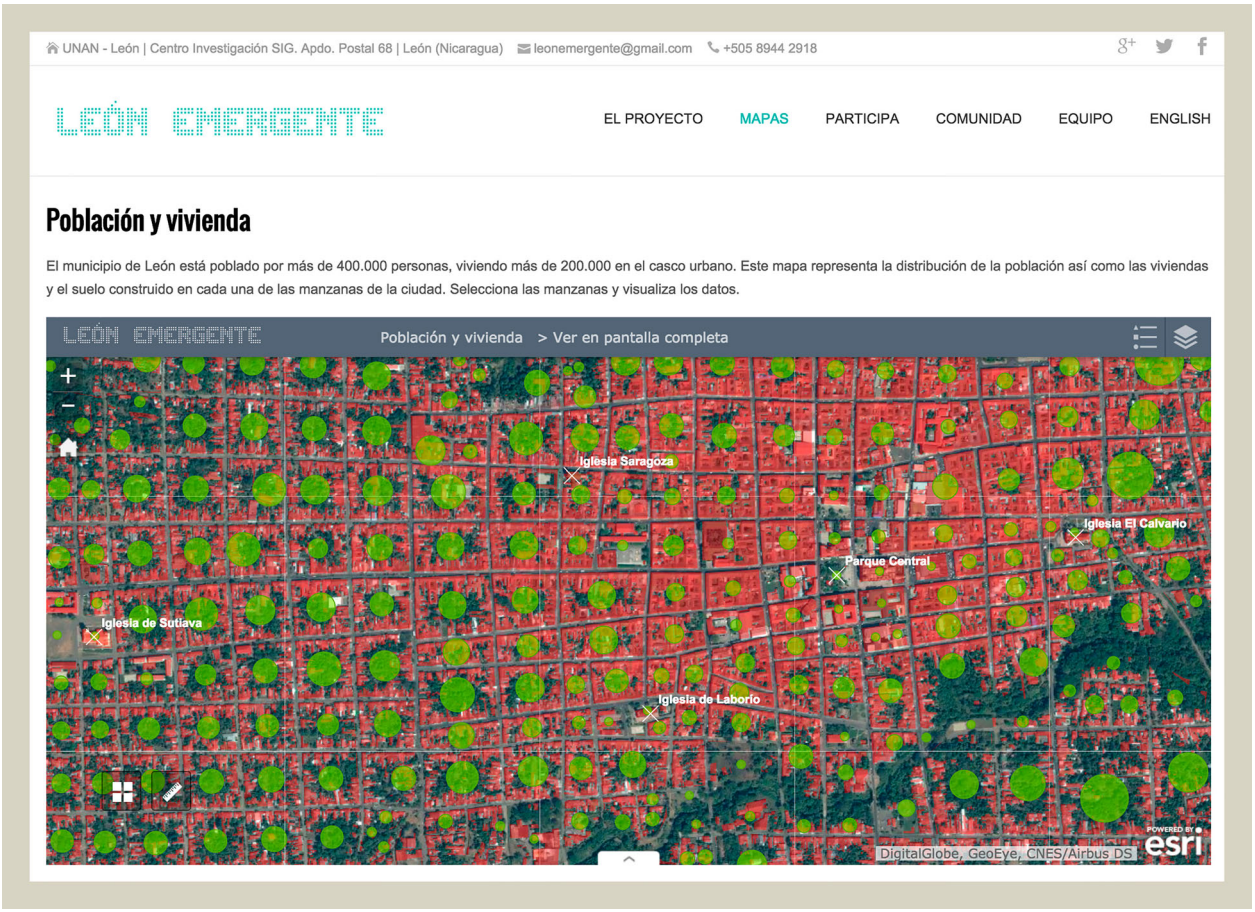

Figure 3. Illustration of the online population and housing map.

cream or smoothie shops. The dataset was initially collected by the second group of participants through street surveys and collected from other volunteers through the online platform once it was launched.

(8) Cultural heritage and urban tourism. The map shows the most important historical buildings, museums and other cultural and tourist sites, including the growing number of tourism agencies. It was developed in collaboration with Medina, an international NGO now working on developing the new Master Plan of León. They provided the dataset.

(9) Health. The map shows the location of the hospitals, health centers, private clinics, veterinarians and numerous pharmacies (around 100 have been mapped so far) spread across the city, including some basic information. The data were offered by the Municipality of León.

(10) Education. The map shows all the academic buildings and facilities, as well as primary and secondary education centers, high schools, language academies, etc. It includes all the facilities related to the University of León (UNAN-León), one of the most important ones in the country. The data on public education facilities were obtained from the Municipality of León, and the data related to private centers were collected through volunteers.

(11) Cooperation and NGOs. There is a growing number of NGOs in Nicaragua and especially in the city of León. The map shows the different NGOs and associations working on social and sustainable development for the city. The dataset was provided by the Municipality of León, and then it was checked and updated by the second group of participants of the initiative.

(12) Leisure and sport. The map shows the numerous sport and leisure facilities, from the city's large baseball stadium to the numerous baseball fields (baseball is the most popular sport in the country), football fields, etc. The dataset was provided by the Municipality of León.

(13) Nightlife. The map shows the many karaoke bars, bars, dance or live music clubs that support the city's active nightlife. The information was obtained from the Municipality of León and collected from volunteers through the online platform.

4. The map

The Main Map canvas includes four different maps that represent two different aspects of the city at two different scales. The map on the left illustrates, for the first time, both formal and informal economic activities in the city of León, which was the project's original objective. All the points shown were collected by means of the *León Emergente* platform, and today is the most extensive geo-referenced database on economic activity in the city in existence. The map shows the retail concentration in certain important city hubs and downtown, while *pulperías* (the local corner shops), professional services and certain informal economic activities are more spread out across the city. Some elements allude to the online platform, such as the header or the pop-up window that includes the different information collected (and now available on the web) regarding the points shown.

On the right, the 'Population and health' map shows, for the first time too, the location of the hospitals, health centers, private clinics, veterinarians and the numerous pharmacies (around 100 have been mapped so far) spread out across the city, including some basic information. In order to visually analyze the location of health facilities according to the distribution of population in the city, the map also illustrates population data, disaggregated by plot.

5. Conclusions

In the growing constellation of collaborative map-making initiatives; there is room for local projects, as well as more global and ambitious ones. They work at completely different levels, meeting diverse needs and achieving different goals. Eventually, they can also establish mutually symbiotic relationships.

Although *Leon Emergente* is a local initiative launched by a small research project, its modest outputs are relevant for the different institutions and actors involved in the development of the city, as well as for the extended community. In any case, as Rambaldi et al. (2006) stated: 'Whilst the focus of traditional GIS applications is often on the outcome, PGIS initiatives tend to emphasize the processes by which outcomes are attained.' It is this focus on *how* the initiative is conceived and developed that makes a difference. *León Emergente* worked because it was conceived from the very beginning along with the local actors, as a specific response to their needs: from education in the use of GIS or the management of the online platform, to the definition of the different outputs (maps and datasets) that could eventually fill some of the existing gaps. It also worked thanks to the participation of people. This was only possible by promoting the initiative as a common project for the benefit of the community as a whole.

Finally, it is important to highlight the potential symbiotic relationships that may be, and should be, established between local and global initiatives. Most of the objectives and results previously described are inherent to local initiatives and cannot be easily reached by global ones. However, initiatives such as

OpenStreetMap (OSM) play an important role in developing countries and often provide the bases for other, more local projects. At the same time, global initiatives can eventually benefit from local ones by integrating some of the outputs obtained, which could allow other people to access these data. For this reason, most of the *León Emergente* data collected are being now reorganized to be uploaded to *OpenStreetMap*.

Software

The *León Emergente* online platform is a *WordPress.org* blog that integrates online maps by using *Web Maps for WordPress* and the *iframe* plugins. The online maps were produced by using the Esri ArcGIS Online platform, creating diverse Apps to implement different functionalities, such as the public edition of maps or the incorporation of photos, video and text, in the case of the so-called *Story Maps*. The Main Map was produced by use of ArcMap 10.3 software. The map was then exported to *Adobe Illustrator CS6* to produce the final map composition.

Esri was chosen because it is the technology currently used by both of the two universities involved in the initiative and in the Municipality of León, so the students and technicians were familiar with it and there was no extra cost for its use.

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